earlier than other muscular tissue. The relation which the amyloid substance bears to it is therefore of much interest. In all embryos, without exception, which I have had an opportunity of examining at a time when they were closely approaching the period of birth, there has been no more than a trace of amyloid substance remaining in the muscular structure of the heart. The preceding Table, drawn up from examination of the heart of the embryo of the sheep, closely represents the corresponding state in other embryos.

The liver, which is the organ destined to form the amyloid matter during adult life, naturally has an increase of this material going on in its tissue up to and after birth: it does not make its appearance in the liver until the embryo is already well advanced in development; it then is found gradually and very slowly to increase in amount, but even at the time of birth is present in comparatively small quantity (2 per cent. in the liver of a lamb 20 inches long).

The rapidly growing horn of a young stag was not found to contain any amyloid substance in the tissues, neither does it exist in the texture of the growing horn of the calf; it is not found in the hair-bulbs of the adult, neither is it to be discovered as a formative material of the newly formed muscular fibres of the uterus when this organ is undergoing its remarkable reconstruction after delivery.

What is the function of this material during fœtal life? It can at least be said it does not change into sugar, neither does it give rise to fat. It seems to be a formative material, which, gradually becoming united with nitrogen, gives origin to the azotized structures.

IX. "Description of a New Mercurial Gasometer and Air-pump." By T. R. Robinson, D.D., LL.D., F.R.S., &c. Received June 2, 1864.

In some experiments on the electric spectra of metal and gases, I felt the want of a mercurial gasometer for working with such of the latter as are absorbable by water. That of Pepys is on too large a scale for my requirements, and it seemed better to contrive one more easily manageable, which I saw could also be made to act as a mercurial air-pump. In this I have succeeded to my satisfaction; and I hope that a description of it may be useful to those who are engaged in similar researches.

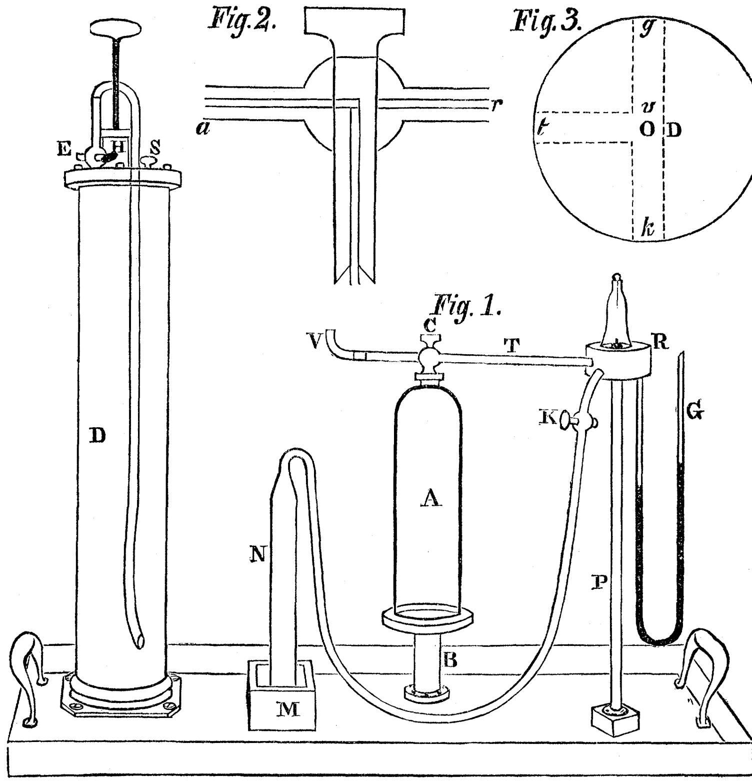
There have been several attempts made to exhaust by means of mercury, the chief of them with which I am acquainted being those of Close (Nicholson's Journal, 4to, iii. p. 264), Edelcrantz (Nicholson, 8vo, vii. p. 188), Traill and Children (Nicholson, xxi. pp. 63 & 161), and that of Geisler, which he uses in preparing the beautiful vacuum-tubes which bear his name. In all the principle is the same. A vessel is filled with mercury, which is made to descend from it, leaving in it a Torricellian

vacuum; this vessel may be made to communicate with a receiver, and abstract from it a portion of the gas which fills it; and by repeating the process the receiver can be exhausted as by successive strokes of an air-pump. In the two first instruments to which I have referred, the descent of the mercury is produced by lifting a plunger which fills one leg of an inverted siphon, the vacuum vessel being at the top of the other leg. On depressing the plunger, the mercury is again forced up to fill that vessel; and of course both legs must be longer than the barometric column. In the two next, the receiver itself is filled with mercury, which, by opening a cock, falls through a tube of sufficient length into a cistern below. Here the stroke (so to call it) cannot be repeated. In Geisler's the bend of the siphon is of vulcanized caoutchouc, so that one leg can be inclined down to a horizontal position, and thus allow the metal to fall from the other, or when raised to the vertical position fill it again. This I believe acts well, but it must be rather unwieldy; and my practical acquaintance with the working of tubes of that material has made me suspicious of their tightness and permanence under such circumstances.

As in all these cases the mercury is supported in the vacuum-vessel by atmospheric pressure, it is obvious that its descent will be produced by removing in any way that pressure; and an effective means of doing this is supplied by the common air-pump; more tedious certainly than the mechanical means above mentioned, but far more manageable; and as any mercurial pump must be slow in its working, while it is only required for special purposes, this defect is not of much importance, and moreover is compensated by some special advantages.

But besides bringing down the mercury, means must be provided for raising it again. My first plan was to do this by condensed air, the same syringe which made the exhaustion having its action reversed by a well-known arrangement. It worked extremely well, was lighter, and required less mercury than the contrivance which I finally adopted; but it is less convenient for gasometric work, as the syringe must be worked while gas is delivered. The machine in its present form is shown in fig. 1. Its base is a stout piece of mahogany, 21 inches by 10·5, with a rim round it 0·5 deep to prevent the loss of any spilled mercury, and handles at the ends by which it can be transported. To this is firmly fixed the iron stand B, 3·5 high, 4 in diameter above; its upper surface is carefully trued to a flanch, in which is cemented the vacuum-bell A, so that when the touching surfaces are lightly smeared with a mixture of lard and wax and screwed together by the six screws (some of which appear in the figure), the joint is air-tight. The bell A is 2 inches in diameter and 6·5 high; it has a tubulure at the top, in which is ground a glass cock C, whose construction is shown in fig. 2. The key of it is pierced from its bottom to a level with the bore, with which this perforation communicates occasionally by a lateral opening. In the position of the figure, it will be seen that the bell communicates with the branch a; if the key be turned half round, it is connected with the

branch *r*; and in an intermediate position it is completely shut off. These glass cocks have this great advantage over those of metal, that it can always



be ascertained if they are air-tight; their transparency permits us to see if the key and shell are in optical contact; and the slightest air-way there is at once detected. They should not be lubricated with oil, which *grips*, and may perhaps find its way into the bell and soil its interior. I find the best material to be castor oil with rosin dissolved in it. A hole is drilled down the axis of B, which communicates by a tube (sunk in the wood and therefore not visible in the figure) with the cast-iron cylinder D. This is 13 inches high and 3·2 in internal diameter; its top and bottom are secured to it air-tight by screws; in it works a plunger of boxwood well varnished 10·4 high, and moving so loosely that mercury may pass it easily. The plunger is wrought by a rod passing through the collar of leather H. In the top of the cylinder is a stopcock E, to which is fixed a tube of vulcanized caoutchouc (varnished with a solution of caoutchouc in benzidine), which is shown hanging down; it has a coupling to connect it with an ordinary air-pump. There is also in the top a screw S for admitting air.

One end of the bell's cock communicates with the atmosphere, the other with the receiver-plate R. This is of glass 2 inches in diameter, 0·75 thick, and is cemented on the top of the iron pillar P. Through it are drilled the passages shown in fig. 3; in *t* is ground the glass tube, shown in fig. 1 by T, the end of which is in contact with the cock, and their junction made air-tight by a tube of Para caoutchouc; in *g* and *k* are similarly ground the siphon-gauge G and the glass cock K. These all communicate with the receiver by the passage *v*, and by removing the tubes can be easily dried or cleaned. The cock K is connected by elastic tube with the catch-jar N, which is supported in a small mercurial trough M.

The operation of this machine as an air-pump is as follows:—The receiver being placed on R, open the screw S, press down the plunger nearly to the bottom of the cylinder, remove the key of the bell-cock, and pour through the opening which it leaves as much mercury as will fill the bell to the bore of the cock. In this one 10 lbs. are required. Raise the plunger to the top, and the metal will subside from the bell till only 0·3 of an inch remains on the top of B, filling the space left vacant in D by the rising of the plunger. The length of the plunger and the height of B must be adjusted to this condition. Replace the key; turn it to communicate with the atmosphere (which position I call (*a*)), and depress the plunger. The mercury will rise again in the bell, filling it, and expelling the air from it, till at last a little mercury will appear in the bore of the cock. To prevent this from being splashed about, a bit of bent tube *v* is ground on the end of the cock, which receives it, and when it has too much is removed and emptied into D through S. Secondly, turn the key to shut off the bell (position (*o*)); draw up the plunger, close S, open E, and couple it to an air-pump, with which exhaust D. This pump may be of the commonest description, for an exhaustion of one or two inches is quite sufficient. The mercury will sink in the bell, leaving above it a Torricellian vacuum. Close E, and turn the key to communicate with the receiver (position (*r*)); its air or gas will expand into the bell.

These three operations form the cycle of operation, and must be repeated till the required exhaustion be obtained, with one modification of the first one. In it, at the second and all subsequent strokes, the key is to be at (*o*) and S opened; thus the atmospheric pressure will raise the mercury and do much of the plunger's work; that must then be depressed and the key set at (*a*); the other two steps are as at first.

When the instrument is to be used as a gas-holder, either the receiver must be in its place, or the opening of R must be closed by a piece of flat glass; the bell must be filled by the plunger, and made, by (*r*) and by opening *k*, to communicate with the jar N. The mercury will rise in that to its neck, and sink in A; fill A again, pass gas into N, and, by carefully working the key, draw it into A till that is full. As this gas will be mixed with the air of the vessels and passages, it must be expelled, and A refilled till its purity is certain. If it be noxious, it must be conducted into some

absorbent fluid by an elastic tube, slipped on the *a* end of the cock; which will also convey the gas to any vessel.

If it be required to fill a receiver for experiments in an atmosphere of gas either at common pressure or a less one,*it may either be exhausted by an air-pump connected with K, and filled from A, or exhausted by A and filled from N. The former can only be done with gases which have no action on brass.

These operations seem complicated when described with so much detail, but in practice they are very easy, and their result is good. Some precautions, however, are required to ensure it. The bottom of the bell-cock and of its key must be ground, so as to leave no shoulder or hollow in which air may be entangled when the bell is filled. Every part of the metal work must be air-tight; this can only be secured by covering, not only its joints, but its whole surface with several coats of varnish-paint—best of white lead. When the first coat is applied, on exhausting the apparatus, every hole or pore is revealed by an opening in the paint (often almost microscopic), which must be filled up as it forms till all is tight. It is almost needless to mention that the whole must be perfectly dry. If the bell be filled a few times with undried air, enough of moisture will adhere to its walls to prevent an exhaustion of more than 0·1 inch. In such a case it must be dried by drawing air into it through sulphuric acid, and this repeatedly. Moisture also occasionally finds its way into a part still more troublesome, into the passage which connects the bell and cylinder; it is probably condensed there when the mercury is colder than the atmosphere. I remove this by connecting the tube of K with a desiccator; setting C to (*r*), opening K and E, and by working the air-pump drawing a stream of dry air into D, which bubbles up through the mercury in the passage, and at last sweeps away all trace of water and its vapour. In this operation it is necessary to remove a portion of the mercury, as otherwise it would be sucked into the pump; indeed this mischief might occur in ordinary work by some mistake in the manipulation—for instance, by leaving E open with (*a*). To prevent the possibility of this, D is connected with the pump by a mercury trap, easily imagined, which intercepts any of that metal that might come over. And lastly, the interior of the bell must be *perfectly clean* if the highest degree of exhaustion is required. This state is obtained by washing it with strong nitric acid, then with distilled water, and when quite dry wiping it with linen, from which all traces of soap or starch have been removed by boiling it in rain-water. Thus we reduce to a minimum the film of air which adheres to the bell even when filled with mercury, and lessens its vacuum. When all these precautions were taken, I found that with a receiver containing 3·7 inches, the fifth operation brought the gauge (which had been similarly cleaned and *carefully* boiled) down to 0·01. The sixth brought it still lower, but my present means of measurement* are not sufficient to determine the precise amount. In this

* A micrometer microscope put in the place of the telescope of my theodolite.

machine the old air-pump theorem ought to hold, and by it, with the fraction $\frac{3 \cdot 7}{17}$, I find that the fifth *should* give 0·007, and the sixth 0·0014; so that the presence of adhering air is still sensible, though very slight. So high a power, however, is not long maintained; for by use, and especially with oxygen, which (probably from the presence of ozone) has a peculiar tendency to dirty mercury, the bell becomes soiled; but it continues to give a vacuum of 0·02, which is quite sufficient for ordinary objects. At common pressure and temperature, the electric discharge through the receiver shows no evidence of the presence of mercurial vapour; but at 0·02 it is otherwise; the discharge is greenish white, and the spectrum shows little except the lines of mercury. If the gauge were detached, perhaps this vapour might be absorbed by gold-leaf.

The apparatus acts well as a mercurial gas-holder, and can deliver 18·5 inches. Like all other contrivances for confining gaseous matter by mercury, it is liable to have its contents contaminated with air by diffusion between the metal and the vessel which contains it; but I expected that in this arrangement the defect would be little felt. In order that it may take place, the air must pass a distance of 17·2 inches, of which 14·6 is a tube only 0·125 in diameter, and the rest is in a vertical direction against the pressure of 2·6 inches of mercury. A single experiment will show how far this avails. The bell was filled with dry hydrogen, which was found to contain 0·901 of the pure gas; it was left for ten days exposed to considerable changes of temperature, and was then found to have 0·854; it was therefore contaminated at the rate of 0·005 per day. I am not aware of similar measures with ordinary mercurial apparatus; nor is this amount of error very important; but it may I believe be corrected by a means long since announced by the late Professor Daniell which has been strangely neglected. He proposed it to prevent the infiltration of air into barometers. If the liquid metal adhered to the surface which it touches, as water would, this action could not occur; now it *wets*, if I may use the word, several metals, as copper or silver, but it also dissolves them, and becomes less fluid. Daniell, however, found that it does *wet* platinum without acting on it in any injurious degree; and advised that a ring of platinum wire should be fused round the tube where it dips into its cistern. On inquiring of his friend and fellow-labourer, Dr. W. A. Miller, I learn that it was completely successful, but was not taken up by the opticians, and passed out of memory. It is obvious that if a bit of platinum tube were cemented in the vertical passage below D, it would effectually bar the diffusion. I do not like to undo the joint there, which is now perfectly tight; but I will certainly, when the opportunity offers, try the experiment.